EGYPTIAN JOURNAL OF BOTANY (EJBO)

Assessing garden ecosystems in the Fayoum Depression of Egypt: An analysis of plant communities, ecological attributes, non-indigenous species, and biodiversity trends

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ARTICLE HISTORY

Submitted: February 12, 2025

Accepted: August 2, 2025

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DOI: 10.21608/EJBO.2025.360262.3193

EDITED BY: Monier Abd El-Ghani

The Fayoum Depression (FD), renowned as one of the world's oldest agricultural hubs and Egypt's most productive agrarian landscape, exhibits a topography strikingly like that of Egypt itself. Qarun Lake, situated along FD's northern boundary, mirrors Egypt's Mediterranean coastline, while the Bahr Yusuf Canal serves as FD's vital water source, akin to the Nile River's role in Egypt. This research examined the floristic composition of cultivated plants, trees, and associated weeds in four public gardens: Fayoum University Gardens (FUG), Fayoum Plantation International Garden (FPIG), Fayoum Governorate Club (FGC), and Fayoum Zoo (FZ). The investigation recognized 216 species from 151 genera across 58 plant families, with Asteraceae, Moraceae, and Fabaceae emerging as the dominant families in the region's flora. Significantly, perennial species (81%) exceeded annuals (19%), a characteristic feature of FD where perennials potentially demonstrate greater resilience to climatic variations. The study identified six life form categories, with phanerophytes (44.91%) and hemicryptophytes (38%) being the most prevalent. Additionally, four primary phytogeographical plant groups were observed: worldwide, bi-regional, pluri-regional, and mono-regional, with bi-regional and mono-regional categories exhibiting the highest representation at 21% and 53%, respectively. Notably, 27 species (13%) were classified as native to the Saharo-Arabian region. Two hundred and sixteen taxa are classified into 175 (81.4%) cultivated and 41 (19 %) wild species, all the cultivated are non-native while the wild species categorized into 18 (8.4%) native and 23 (11%) non-native species. This research contributes valuable insights into the floristic diversity and distribution of cultivated trees and weeds in the Fayoum area, enhancing our comprehension of these gardens' ecological characteristics and informing future conservation and management approaches.

Keywords: Chorology, Fayoum Depression, Gardens, Floristic composition, Life form, Life spin

INTRODUCTION

The floristic composition of gardens and parks plays a critical role in biodiversity conservation as it directly influences the diversity of plant species present, which subsequently supports various wildlife, including animals, insects, and microorganisms (Paudel & States, 2023). Diverse plant assemblages enhance ecosystem functions, such as pollination, soil health, and climate regulation, thereby maintaining the ecological balance and resilience of urban environments (de Barros Ruas et al., 2022). Furthermore, research underscores that gardens and parks serve as essential green spaces that contribute to the overall urban biodiversity (Aram, 2024).

In addition to the diverse composition of ornamental plants in Egyptian gardens, they play a role in conserving wild plants that naturally coexist with ornamental species (Ammar, 2021). Despite the rich diversity and substantial wealth of garden plants in Egypt, particularly when compared with Egyptian wild flora, there remains an absence of a comprehensive documentary survey of these plants. It is imperative to undertake a documentary analysis of this group of plants, acknowledging that their composition and presence change owing over time due to factors such as garden size, human impact, human requirements, irrigation sources, availability of water, and climatic elements such as temperature, drought, humidity, and precipitation (Ammar, 2021). Given that some of these species are listed as IUCN threatened species, it is crucial to focus on the role of Egyptian gardens in conserving wild plants, particularly endangered species such as Medemia argun (Abo Hatab et al., 2024).

Phytogeographical distribution analysis critical method for understanding the distribution of plant species and their natural habitats. Additionally, this approach sheds light on the historical ranges and environmental conditions necessary for plant survival as well as their natural dispersal patterns. By analyzing the distribution of plant species across various regions, conservation efforts can be prioritize in areas with high biodiversity (Asatulloev et al., 2023).

Since the era of Mohammed Ali (1805-1844), the introduction and acclimatization of new plants have received considerable attention in Egypt. His renowned son, Ibrahim Pasha, established a garden in Rodah, where numerous ornamental trees, now extensively cultivated in the country, were first introduced. However, the advent of the modern European style of horticulture in Cairo gardens began during the reign of Khedive Ismail (1863 – 1879) (El-Sheshtawy, 1969). This period is notable in Egyptian history for the establishment of several large experimental gardens and public parks (Hamdy et al., 2007). The creation of gardens has persisted to the present day in various regions of Egypt, with the Fayoum Depression as a notable example.

The Fayoum Depression (FD) is regarded as one of the oldest agricultural cities globally and has the most fertile agricultural landscape in Egypt. This depression, located within the Libyan Desert, is connected to the main valley trunk by a narrow neck-like linkage. It covers an area of approximately 1,700km² and is positioned approximately 95km² southwest of Cairo. Symbolically, it represents a lateral bud, with the Delta as the flower and the Valley as the stem of a Lotus plant. It spans longitudes 30°23' to 31°5' E and latitudes 29°5' to 29°35'N, with a mean annual temperature of 20.9ºC and an average annual rainfall of 7mm (Al-Sherif et al., 2018). The topography of the Fayoum Depression parallels that of Egypt, with Qarun Lake located on the northern coastline of Fayoum, analogous to Egypt's northern frontier with the Mediterranean Sea, and the Bahr Yusuf Canal serving as the backbone of the region, similar to Egypt's Nile River (Ellmouni et al., 2021).

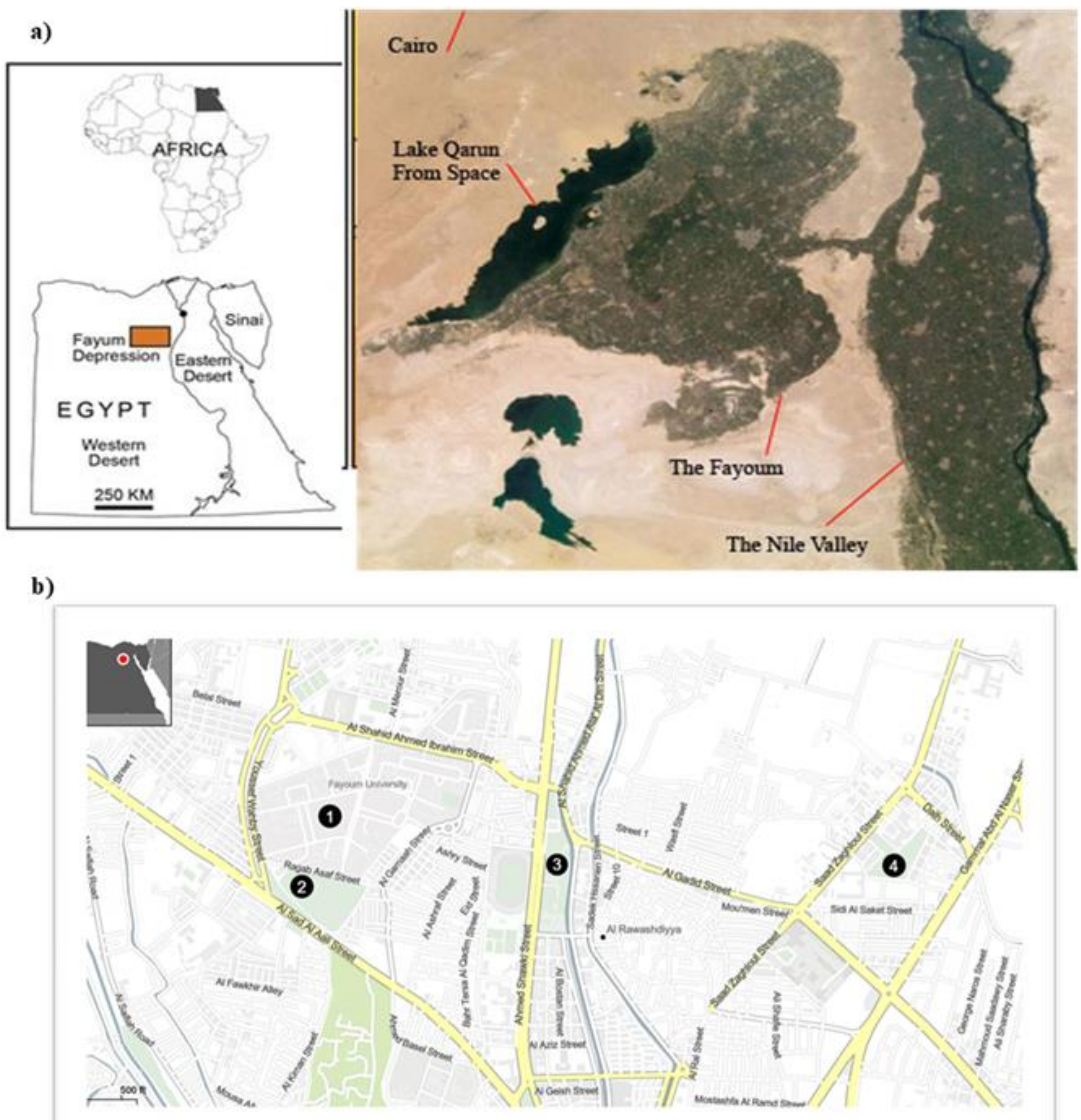
The examination of diverse species, along with the analysis of their life forms and phytogeographical origins, provides crucial insights into the region's biodiversity (Waheed et al., 2024). Significantly, the extant literature exhibits a scarcity of publications concerning garden flora in the area under investigation. Consequently, this research sought to conduct a comprehensive and illuminating survey of the floristic composition within four notable gardens situated in the Fayoum Depression: Fayoum University Gardens (FUG), Fayoum Plantation International Garden (FPIG), Fayoum Governorate Club (FGC), and Fayoum Zoo (FZ).

MATERIALS AND METHODS

The research was carried out within the Fayoum Depression (FD) area, collecting data concerning the flora of cultivated trees and weeds during the Autumn/Winter 2023 growing seasons. Plant samples were systematically collected from four frequently visited gardens: Fayoum University Gardens (FUG), Fayoum Plantation International Garden (FPIG), Fayoum Governorate Club (FGC), and Fayoum Zoo (FZ) (Map 1).

Plant collection and species identification

The taxa identified were consistent with the flora references as delineated in the Plant Atlas; The Botanic Garden, Garden Plant Diversity (Täckholm, 1974; Boulos, 1999, 2000, 2002, 2005; Heneidy, 2010; Bayton, 2020; Ammar, 2021). The nomenclature of plant taxa adheres to the checklist provided by Boulos (2009). The data have been updated using the Taxonomic Name Resolution Service (TNRS) (Boyle et al., 2013) and the Plants of the World Online (POWO, 2025). Voucher specimens were deposited in the herbarium of the Botany Department, at the Faculty of Sciences, Fayoum University, Egypt. Life form categories were classified according to Raunkiaer's taxonomy, while the phytogeographical categories were delineated based on the frameworks established by Takhtajan (Takhtajan, 1986), Zohary (Zohary, 1973), and White and Leonard (White & Léonard, 1991). The floristic areas can be summarized as follows: Neotropical (NEO), Paleotropical (PAL), Pantropical (PAN), American (AM), Australian (AUS), Cosmopolitan (COSM), Euro-Siberian (ES), Irano-Turanian (IT), Mediterranean (ME), Saharo-Arabian (SA), Saharo-Sindian (SS), and Tropical (TR). Taxonomic diversity within each garden was evaluated utilizing the parameters Ns (number of taxa), Ng (number of genera), and Nf (number of families). Differentiation indicators included the species differentiation index (Ds = Ns/Ng), genus differentiation index (Dg = Ng/Nf), and species-family differentiation index (Dsf = Ns/Nf) to describe divergence among endemic taxa (Huang et al., 2016). Three indicators evaluated taxa in each garden: single-taxa at the region (STR), bi-taxa region (BTR) for multiple gardens, and tri-taxa region (TTR) (Abd El-Ghani et al., 2024).



Map 1. a) Map of Fayoum depression location at Egypt and Africa (Holdaway, 2012) and https://www.touregypt.net/featurestories/lakeqarun.htm , 1b) Map of the Fayoum Depression (FD) region of shows the study area's location: 29°18'30.2"N 30°50'34.1"E , (1) Fayoum University Gardens (FUG); 29°19'15.0"N 30°50'07.6"E (2) Fayoum Plantation International Garden (FPIG); 29°19'03.8"N 30°50'02.8"E (3) Fayoum Governorate Club (FGC); 29°19'06.7"N 30°50'29.0"E (4) Fayoum Zoo (FZ) ; 29°19'13.8"N 30°51'11.9"E, created by https://online.mapcreator.io/.

The performance of statistical analyses, charts, and histograms was conducted utilizing Microsoft Excel. The study was facilitated using R software with the assistance of the R Development Core Team (R Core Team R, 2016) and RStudio (RStudio Team, 2015). A chord diagram was generated using the "circlize" package (Gu et al., 2014). Correlation coefficients were assessed using the "Corrplot" package (Soetewey, 2022) to reveal the relationships among variables: a coefficient of 0, denoted by white, indicates no association, a coefficient of 1, depicted in blue, indicates a strong positive correlation, while a coefficient of -1, shown in red, indicates a negative correlation.

RESULTS

Floristic composition for all taxa

A comprehensive inventory of all taxa collected from four gardens, detailing their presence or absence, life forms, chorology, and lifespan provides at Supplementary Table 1. The investigation revealed a total of 216 vascular plant species, within the esteemed gardens at FD. These taxa were distributed across 151 genera and 58 plant families (Table 1). Dicotyledonous families dominated the composition, representing 75% of the total, followed by Monocotyledonous families at 21%, and gymnosperms at 4% (8 species) (Table 1, Figure 1a). Among the Monocotyledonous families, Asparagaceae, Arecaceae, Poaceae, and Amaryllidaceae were identified. The analysis of species lifespan revealed that perennials constituted the majority at 81.48% (176 species), while annuals comprised 18.52% (40 species) (Figure 1b).

The floristic analysis highlighted the following family distributions: Asteraceae (16 species; 12 genera), Moraceae (15 species; 2 genera), Fabaceae (13 species; 11 genera), and Asparagaceae (12 species; 6 genera), constituting 7.41%, 6.94%, 6.02%, and 5.56% of the total flora, respectively. Twenty-eight plant families were represented by at least one species (14%), while nine families comprised two to three species, accounting for 4% (Figure 2).

The study identified six classes of life forms: Cryptophytes, Geophytes, Helophytes, Hemicryptophytes, Phanerophytes, and Therophytes. A chord diagram illustrating life forms by species and family numbers revealed Phanerophytes as the dominant group, encompassing 97 species (45%) across 36 families (38%), followed by Hemicryptophytes with 81 species (38%) distributed among 34 families (35%). Figure 3 depicts the relative percentages of each life form in terms of species and family numbers (Figure 3).

Nationalization status

A total of 216 taxa have been categorized, with 175 identified as cultivated species, accounting for 81.4% of the total, all of which are non-native. The remaining 41 taxa are classified as wild species, comprising 18 native species (8.4%) and 23 non-native species (11%) (Figure 4). The documented species indicate that 122 taxa possess at least one aspect of economic utility, while 110 taxa have environmental applications. Medicinal plants (118 taxa=54.9%) were the most prevalent, followed by human food sources (93 taxa=43.3%), grazing resources (54 taxa=25.1%), and toxic plants (53 taxa=24.7%). Additionally, all cultivated plants serve an ornamental function (Figure 5).

The study area encompasses four principal biogeographical zones: Irano-Turanian, Saharo-Arabian, Saharo-Sindian, and Mediterranean, alongside American, Australian, Cosmopolitan, Pantropical, Paleotropical, and Tropical zones. The Saharo-Arabian and Irano-Turanian regions exhibited the highest representation, accounting for 13% (27 species) and 12% (25 species) of the total observed species, respectively.

Tabel 1. List of family, genera, and species numbers at classified Dicotyledonous, Monocotyledonous and gymnosperms categories.

Class	Dicotyledonous	Monocotyledonous	Gymnospermae
Family No.	43	13	2
Genus No.	113	32	6
Species No.	167	41	8

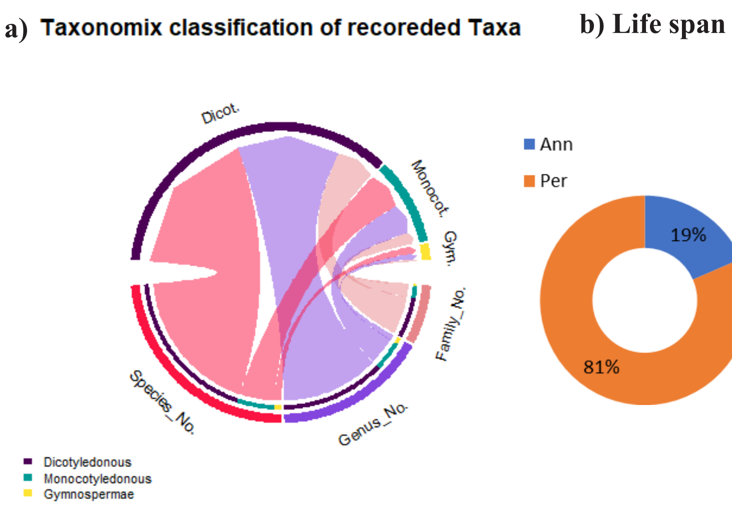


Figure 1. a) Chord diagram of the family, genera and species number based on class Dicotyledonous and Monocotyledonous. b) pie chart for life span

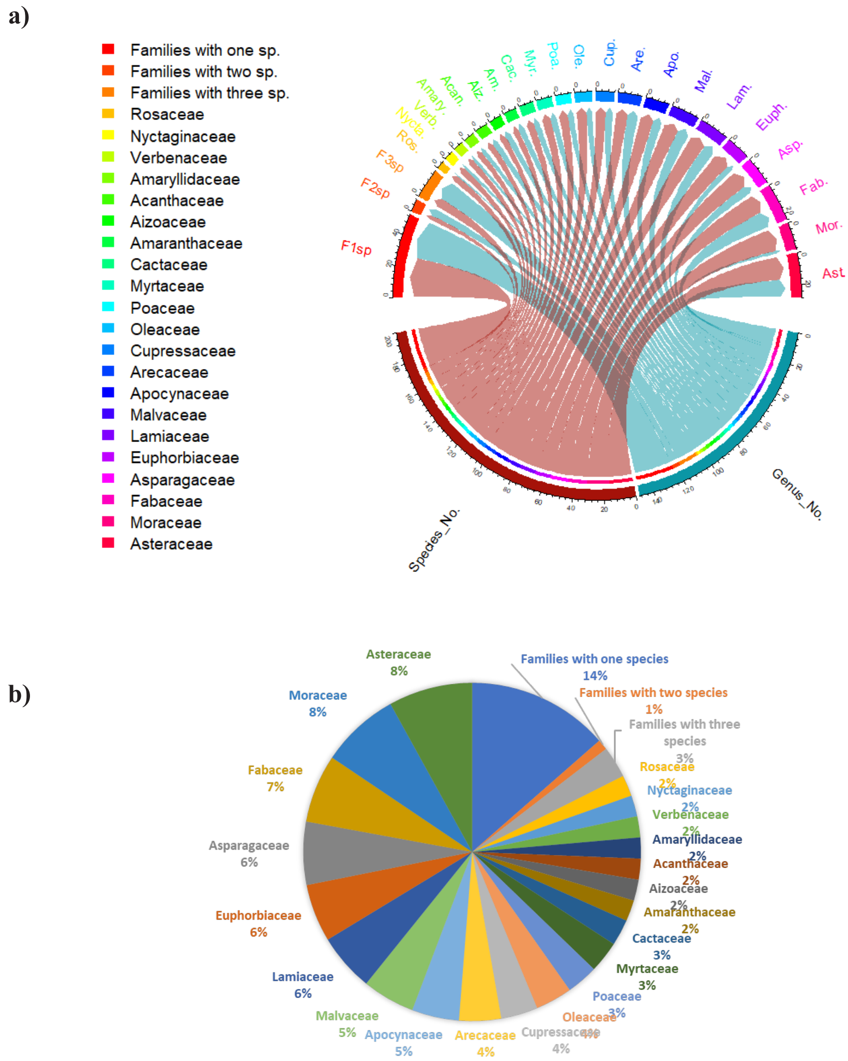


Figure 2. a) Chord diagram for genus No and species No. per plant families b) pie chart for the proportional contribution of plant families at present study

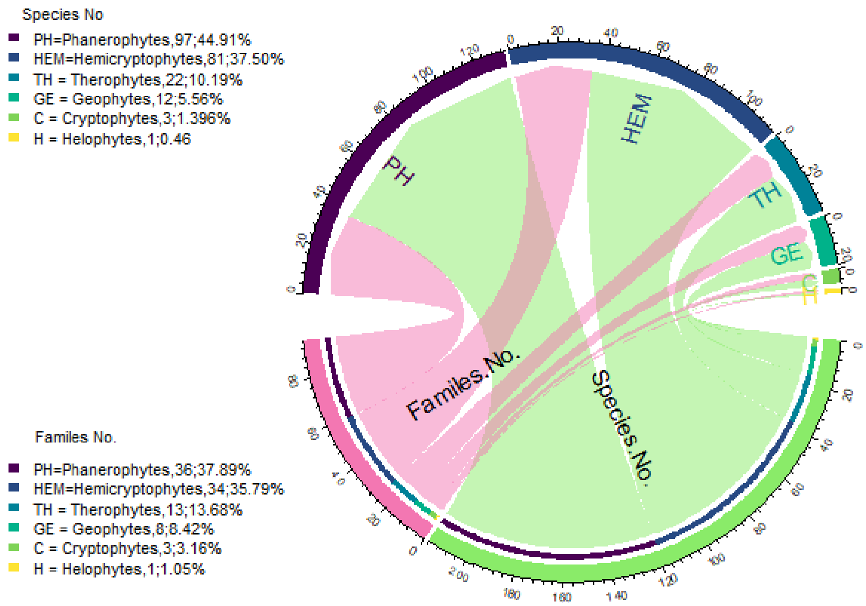


Figure 3. Chord diagram of Life forms (CR= Cryptophytes, GE= Geophytes, HEL= Helophytes, HEM= Hemicryptophytes, PH= Phanerophytes, TH = Therophytes)

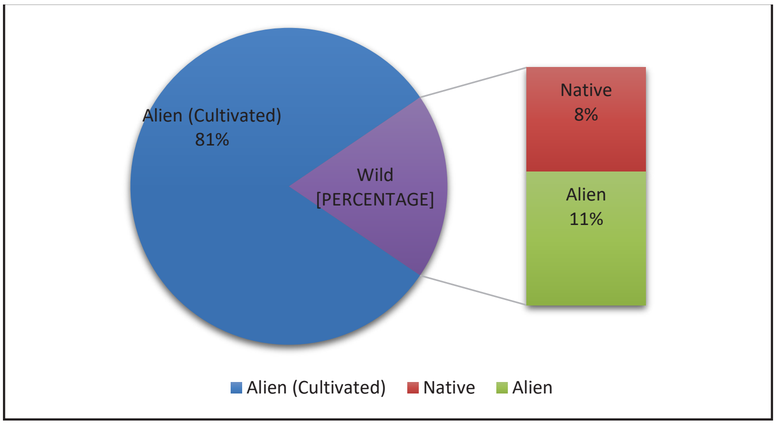


Figure 4. The percentage of different taxa status of the recorded species

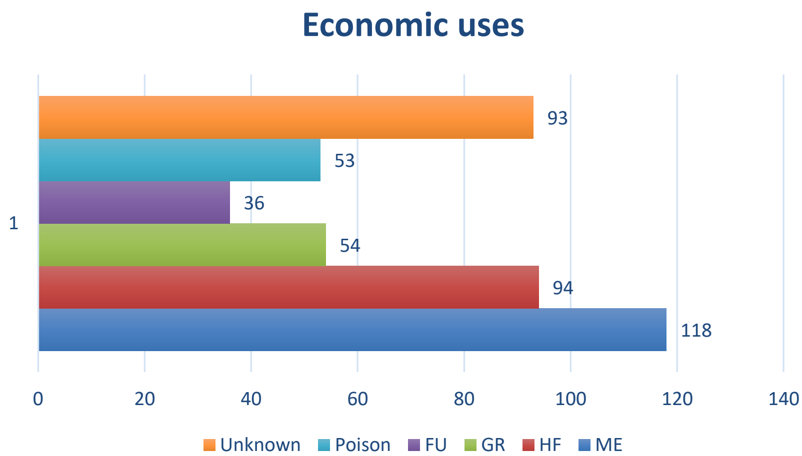


Figure 5. Economic uses of recorded species [Economic uses are ME: Medicinal purposes, HF: Human food, GR: grazing and FU: Fuel]

In phytogeographical classification, plant taxa are categorized based on their distribution patterns into Monoregional (confined to a single region), Bi-regional (spanning two regions), Pluri-regional (distributed across multiple regions), and Worldwide (globally distributed) types. The chorological investigation of the assembled taxa revealed the predominance of the Mono-regional group, comprising 114 species (52.78%). This group encompassed eleven chorotypes, with the Saharo-Arabian being the most substantial, representing 27 species (12.5%). The Saharo-Arabian region was associated with ten additional regions, including Saharo-Arabian/Mediterranean (2.31%), as illustrated in Table 1. The Irano-Turanian region followed with 25 species (11.57%), while the American region contributed 24 species, constituting 11.11% of the Mono-regional elements. The Worldwide collection consisted of 47 species, representing 21.76% of the examined taxa. The Paleotropical region included 20 species, accounting for 9.26%. The Pantropical and tropical regions exhibited the lowest percentages at 4.63% and 2.78%, respectively. The Bi-regional elements encompassed 13 primary chorotypes with 45 taxa (20.83%). The Pluri-regional category influenced seven chorotypes, comprising 4.63% with 10 species (Figure 6, Table 2).

Taxonomic diversity, degree of differentiation, and distribution patterns of taxa based on four gardens.

An examination of the flora composition of cultivated trees and weeds was conducted across four common gardens: Fayoum University Gardens (FUG), Fayoum Plantation International Garden (FPIG), Fayoum Governorate Club (FGC), and Fayoum Zoo (FZ). The bar plot depicted the taxonomic classification of taxa within the four gardens. FUG exhibited the highest diversity of dicotyledonous families, with 30 species (30.93%), but the lowest diversity in monocotyledonous families, with only 4 species (16.67%). Both FUG and FGC gardens contained two gymnosperm families. FPIG and FGC displayed similar counts of dicotyledonous species: 24 (24.74%) and 25 (25.77%) respectively, each hosting 7 monocotyledonous species (29.17%) (Figure 7).

The chord diagram illustrating taxonomic diversity across the four gardens indicated that FUG possessed the highest counts of families (Nf), genera (Ng), and species (Ns) (Figure 8a). It also demonstrated the highest genus differentiation (Dg) and species-family differentiation index (Dsf). In contrast, FZ exhibited the lowest indices and overall taxonomic diversity (Figure 8b).

The assessment of taxa for each garden utilized three indicators: (1) single-taxa at region (STR), representing the number of taxa unique to a garden; (2) bi-taxa region (BTR), indicating species shared between gardens; and (3) tri-taxa region (TTR), denoting species present in multiple gardens. The chord diagram and line figure derived from the analysis of the four gardens demonstrated that 49 species (38%) were classified as single-taxa at the FGC garden (STR), while the FUG garden exhibited 24 species in the bi-taxa region (BTR) (Figure 9).

Correlation analysis between Taxonomic diversity, degree of differentiation, and distribution patterns revealed a significant positive relationship between no of dicot family (Ndi) with number of families (Nf), number of taxa (Ns) and *Bi-taxa region (BTR).* Additionally, the number of genera (Ng), number of taxa (Ns), genus differentiation (Dg), and the species-family differentiation index (Dsf). Moreover, the number of taxa (Ns) showed a positive correlation with the species-family differentiation index (Dsf) and genus differentiation (Dg). Insignificant negative correlation was observed at no of monocot family (Nmon) with the most of indcatores except *Single-taxa* (STR) and Tri-taxa region *(*TTR) have positive corrlation (Figure 10).

DISCUSSION

In recent decades, the importance of the green world, the diversity of plants have been recognized and valued at different levels (Pullaiah & Galbraith, 2023). The garden flora in the Egyptian Nile Region consists of 2470; subspecies or varieties of ornamental plants (Ammar, 2021). The floristic composition of the gardens in the Fayoum Depression (FD) is noteworthy, revealing a total of 216 vascular plant species across 151 genera and 58 families. The dominance of dicotyledonous families, which comprised 75% of the total species, underscored the biodiversity richness in these gardens. The predominance of perennial species (81.48%) over annuals species (18.52%) aligns with the garden's cultivated nature (Heneidy, 2010). Plants are typically chosen for their longevity and aesthetic appeal. Annuals are likely introduced or naturalized species that have adapted to the garden environment, such as *Trianthema portulacastrum, Hibiscus sabdariffa, Cenchrus ciliaris,* and *Lantana camara* (Shaltout, 2020).

Table 2. The number of the documented taxa fitting to the main floristic categories and percentages (%)

Monoregional			Bioregional			Pluri-regional			Worldwide		
SA	27	12.50%	PAL+PAN	22	10.19%	ES+ME+SA+SS+PAL+PAN	3	1.39%	PAL	20	9.26%
IT	25	11.57%	AM+COSM	6	2.78%	IT+SZ+SA	2	0.93%	COSM	11	5.09%
AM	24	11.11%	ME+SA	5	2.31%	AM+COSM+PAL+PAN	1	0.46%	PAN	10	4.63%
ME	16	7.41%	AM+PAN	2	0.93%	ME+SA+ES+IT+PAL+PAN	1	0.46%	TR	6	2.78%
ES	12	5.56%	IT+ME	2	0.93%	ME+SA+IT+PAL+PAN	1	0.46%	**Sub-total**	47	21.76%
AUS	5	2.31%	AM+SA	1	0.46%	SA+AUS+PAL+PAN	1	0.46%			
SS	2	0.93%	EU+ME	1	0.46%	SA+PAN+PAL	1	0.46%			
SZ	2	0.93%	IT+AM	1	0.46%	**Sub-total**	10	4.63%			
EU	1	0.46%	IT+Neo	1	0.46%						
Sub-total	114	52.78%	IT+SA	1	0.46%						
			ME+ES	1	0.46%						
			SA+IT	1	0.46%						
			SA+SZ	1	0.46%						
			Sub-total	45	20.83%						

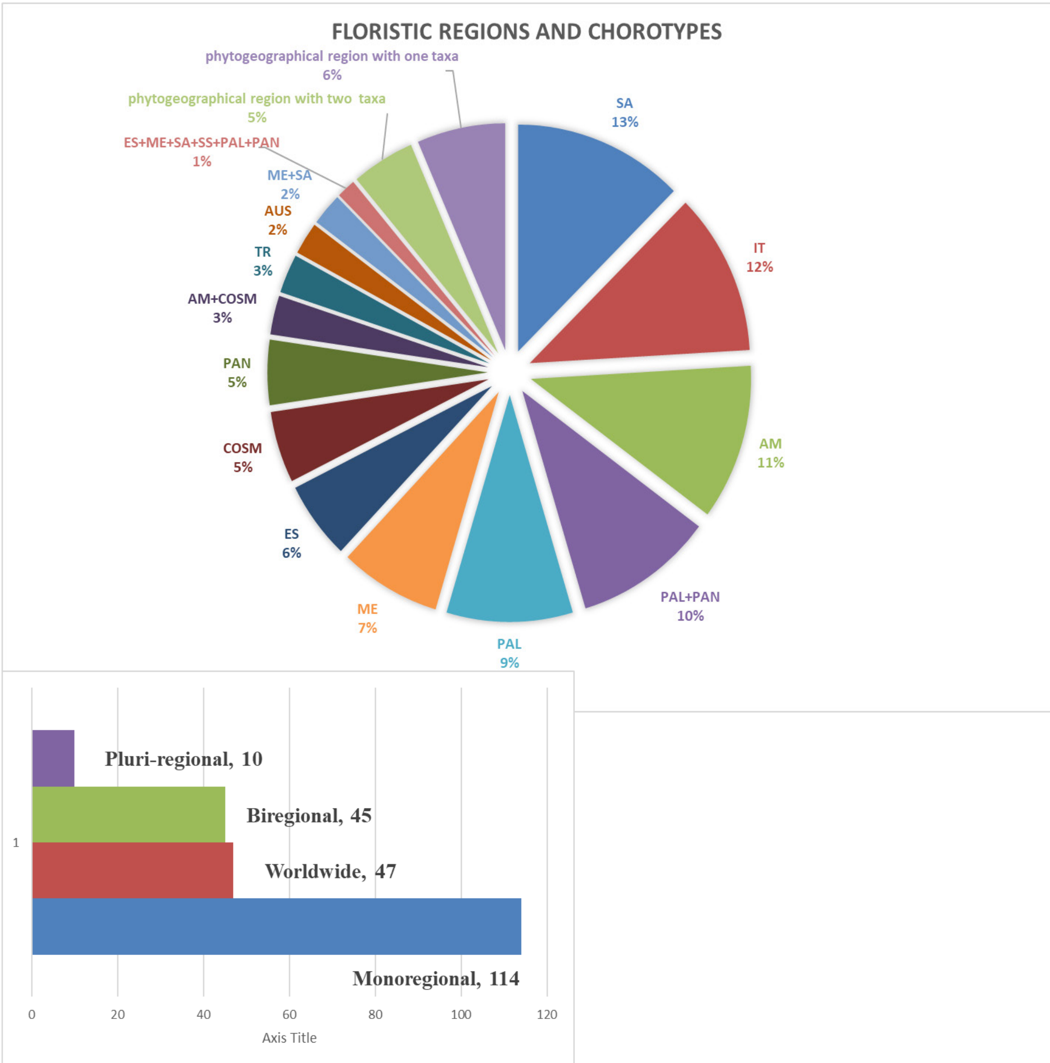


Figure 6. Floristic regions and chorotypes [Note: Chorotypes: American (AM), Australian (AUS), Cosmopolitan (COSM), Euro-Siberian (ES), Irano-Turanian (IT), Mediterranean (ME), Paleotropical (PAL), Pantropical (PAN), Saharo-Arabian (SA), Saharo-Sindian (SS), Sudano-Zambezian (SZ) and Tropical (TR)]

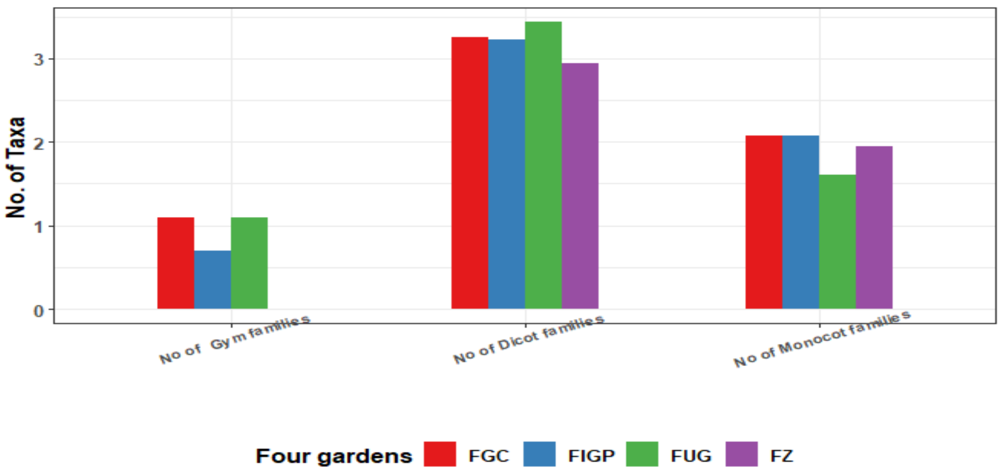


Figure 7. Bar plot for the classified taxonomic family at four gardens

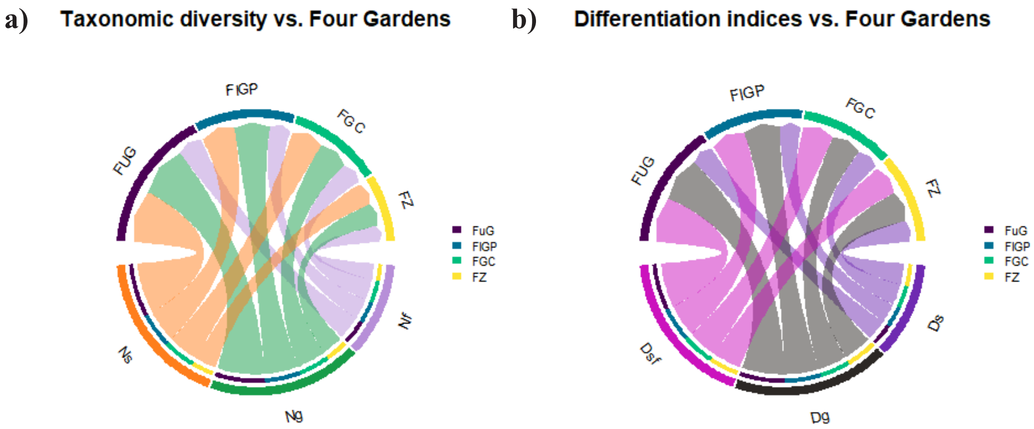


Figure 8. a, b) Chord diagram of taxonomic diversity and differentiation indices at four gardens

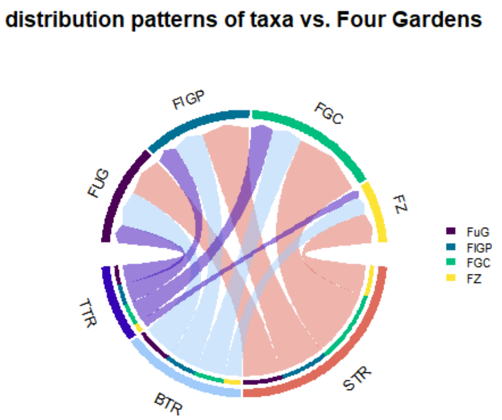


Figure 9. Chord diagram for distribution patterns based on four gardens

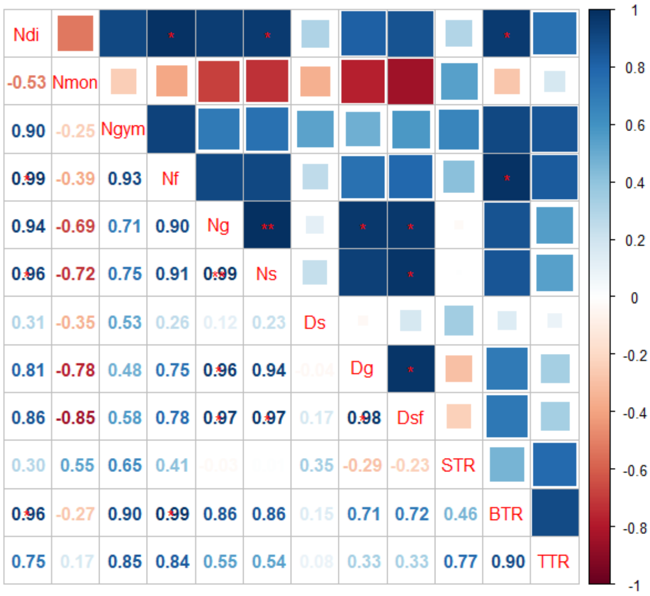


Figure 10. Pearson's correlation coefficients (r). between Taxonomic diversity, degree of differentiation, and distribution patterns [Abbreviations: Ndi no of dicot family, Nmon no of monocot family, Ngym no of gymnosperm family, Ns number of taxa, Ng number of genera, Nf number of families, Ds Species differentiation index, Dg Genus's differentiation index, Dsf Species–family differentiation index, STR Single-taxa at region, BTR Bi-taxa region, and TTR Tri-taxa region, correlations are significant on level 0.01**, 0.05*]

Previous studies on Egyptian garden flora has established distinct but limited foundations (Abd El-Ghani et al., 2007) provided critical historical documentation, focusing exclusively on six major Khedival-era botanical gardens in 19th-century Cairo. Complementing this temporal focus, Ammar (2021) systematically assessed contemporary floristic diversity, yet reinforced a significant geographical constraint by confining analysis to the Nile region. This collective emphasis has resulted in a persistent knowledge gap regarding the horticultural biodiversity of the Fayoum Depression. While Afefe (2020) addressed local biodiversity by cataloging wildland floristic composition in the Fayoum, anthropogenic garden environments within this distinct ecosystem remained unexamined. Consequently, this study bridges these critical gaps by conducting the first comprehensive assessment of garden-specific plant biodiversity within the Fayoum Depression. This work directly addresses the identified research void and provides novel insights distinct from prior foundational, historical, regional, and wildland-focused studies.

Gardens play a critical role in biodiversity conservation by acting as reservoirs for a diverse range of plant species, including aliens, native, and cultivated taxa (Staude, 2024). The present study findings revealed that 81.4% of the recorded taxa are cultivated species, all of which are alien. This highlights a significant level of human modification and the dominance of non-native species in the study area, which presents a challenge for achieving Sustainable Development Goal (SDG) 15. SDG 15 aims to halt biodiversity loss, promote sustainable ecosystems, and specifically targets controlling invasive alien species. This high representation underscores the importance of managed gardens in housing alien species that may not survive in the wild. However, the presence of wild species, including native taxa (8.4%) and alien species (10.2% classified as casual, naturalized, or invasive), emphasizes the potential for gardens to act as both sanctuaries and sources of plant dispersal into natural habitats. For example, *Carpobrotus edulis*, recorded among the cultivated alien species, has been observed to spread into natural ecosystems in Abu Qir, Alexandria (31.3256889N, 30.0643766E), posing risks of invasion. (Plate 1) This highlights the dual role of gardens in conservation and the necessity of stringent control measures to prevent potential ecological imbalance caused by invasive species, aligning SDG targets to minimize the impact of invasive species impacts on ecosystems (GBIF. Org., 2025).

Plate 1. The high spread of *Carpobrotus edulis* in the natural habitat photo taken by Dr. Soliman M. Toto

This study highlights the pivotal role of gardens, particularly cultivated and alien species, in advancing sustainable development by contributing to biodiversity conservation, economic benefits, and ecological services. The economic and environmental uses of the recorded taxa further accentuate the significance of the gardens. Among the species studied, 122 taxa exhibited economic applications, and garden roles in mitigating climate change and supporting ecosystem services further supported SDG 13 by fostering resilience and adaptation through diverse plant species with environmental uses (110 taxa recorded). Additionally, gardens' multifunctionality, as shown in the study, supports SDG 12, which promotes sustainable resource use, such as medicinal plants, grazing species, and ornamental plants, which offers both economic and aesthetic benefits. Medicinal plants, representing 54.9% of taxa, highlight the critical contribution of gardens to human health and traditional medicine. Other uses, such as human food (43.3%), grazing (25.1%), and poisons (24.7%), demonstrated the wide-ranging utility of these species. Additionally, the ornamental use of all cultivated plants enhances the aesthetic and cultural value of gardens, promoting biodiversity appreciation among the public (GBIF.Org., 2025).

These findings suggest that while gardens play a pivotal role in conserving biodiversity and offering ecosystem services, they also require active management to mitigate the risk of alien species spreading into natural habitats. This balance is vital for leveraging gardens as tools for biodiversity conservation, while safeguarding natural ecosystems from invasive threats. Moreover, the study shows the educational and ecological value of gardens in raising awareness about biodiversity and sustainability among the public, contributing to SDG 4 on quality education. Through such integrative roles, gardens have emerged as vital tools for promoting a harmonious relationship between humans and nature, ensuring resource availability for current and future generations (GBIF.Org., 2025). This stability was further evidenced by the significant presence of phanerophytes (44.91%) and hemicryptophytes (37.5%), suggesting an environment that supports a diverse range of life forms.

The analysis of taxonomic diversity highlights the contributions of specific families, with Asteraceae (7.41%), Moraceae (6.94%), Fabaceae (6.02%), and Asparagaceae (5.56%), of the total flora. This diversity is indicative of the ecological niches available within the gardens and the effectiveness of the cultivation practices. The representation of at least 28 families suggests a healthy ecosystem, although the concentration of species within a few families could indicate potential vulnerability in the face of environmental changes or human-induced pressures (Abd El-Ghani et al., 2015).

Chorological analysis revealed a significant representation of mono-regional taxa (52.78%), particularly the Saharo-Arabian group, which aligns with the geographic and climatic characteristics of the Fayoum Region (Afefe, 2020). This finding emphasizes the importance of local flora and the role of these gardens in conserving endemic species (Ammar, 2021). The presence of worldwide species (21.76%) suggests that these gardens are not only vital for local biodiversity but also serve as a refuge for species from various biogeographic regions, enhancing their ecological significance.

When examining taxonomic diversity among the four gardens, Fayoum University Gardens (FUG) stood out, with the highest variety of dicotyledonous families (30.93%), reflecting its effective management, human activities, and potential for research and conservation. The contrasting diversity indices between gardens, with FUG demonstrating higher differentiation, indicate varying management practices and ecological conditions. The low diversity observed in Fayoum Zoo (FZ) may reflect limited plant cultivation practices or less favorable growing conditions.

Correlation analysis provides valuable insights into the relationships among species, genera, and families within these gardens. The significant positive correlations suggest that increased genus differentiation and number of taxa are likely linked, reinforcing the idea that richer biodiversity contributes to more distinct ecological communities (Ammar, 2021). The assessment of unique and shared taxa among gardens revealed a diverse interplay between local and regional flora. The identification of 49 single-taxa species in the Fayoum Governorate Club (FGC) indicates its potential as a unique ecological habitat. Conversely, the presence of shared species across gardens highlights the interconnectedness of these ecosystems and the importance of collaborative conservation.

Finally, this study highlights the substantial floristic diversity present in Fayoum gardens and their vital function in preserving cultivated trees, wild plant species, and threatened taxa. This underscores the importance of ongoing surveillance and documentation to enhance our understanding of these ecosystems, facilitate sustainable resource management, and refine conservation approaches tailored to the unique attributes of each garden.

CONCLUSION

The findings of this study reveal diverse flora within the renowned FD gardens, encompassing 216 species from 151 genera and 58 families. Dicotyledons predominated, followed by monocotyledons and gymnosperms. Perennials exceed annuals in number, with phanerophytes and hemicryptophytes being the most common life forms. Chorological analysis indicated a prevalence of mono-regional taxa, particularly those affiliated with the Saharo-Arabian region, suggesting a strong influence from the surrounding arid environment. While numerous species are present worldwide, regional affinities remain evident.

Comparative examination of tree and weed flora across the four Fayoum gardens revealed significant variations taxonomic diversity. The FUG garden exhibited the highest overall diversity, whereas the FGC garden demonstrated unique single-taxon richness. Differentiation indices revealed distinct patterns: FUG showed the greatest genus and species-family differentiation, indicative of more specialized flora, whereas FZ displayed lower differentiation and taxonomic diversity. Distribution patterns further accentuate each site's uniqueness, with FGC hosting the most single-taxon species and FUG sharing many species with other gardens. Correlation analysis revealed robust positive relationships among taxonomic metrics, indicating a connection between family and genus level diversity and taxa quantity.

RECOMMENDATIONS

1. Given the crucial role of public parks in biodiversity conservation, as evidenced by this study, increased attention and allocation of sufficient space to these areas is advised.

2. The prevalence of non-native ornamental plants necessitates constant monitoring to prevent their invasive spread, as exemplified by *Carpobrotus edulis* in wild habitats.

3. Implementation of stringent regulations governing the ornamental plant trade is recommended, establishing criteria for species importation and cultivation within gardens.

Acknowledgements: The researchers extend their appreciation to the Botany Department and the Faculty of Science, Fayoum University for furnishing the necessary facilities that facilitated this investigation, enabling the undergraduate student co-authors to procure all taxa required for the study.

Conflicts of interest: The authors declare that they have no competing interest.

Authors' contributions: All authors consented to participate, read and approved the final manuscript for publication.

Funding: This research received no external funding.

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